Using Maximal Isometric Force to Determine the Optimal Load for Measuring Dynamic Muscle Power

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Abstract

Maximal power output typically occurs when subjects perform ballistic exercises using loads of ~30% of one-repetition maximum (1-RM). However, performing 1-RM testing prior to power measurement requires considerable time, especially when testing involves multiple exercises. Maximal isometric force (MIF), which requires substantially less time to measure than 1-RM, might be an acceptable alternative for determining the optimal load for power testing. PURPOSE: To determine the optimal load based on MIF for maximizing dynamic power output during leg press and bench press exercises. METHODS: Twenty healthy volunteers (12 men and 8 women; mean ± SD age: 31 ± 6 y; body mass: 72 ± 15 kg) performed isometric leg press and bench press movements, during which MIF was measured using force plates. Subsequently, subjects performed ballistic leg press and bench press exercises using loads corresponding to 20%, 30%, 40%, 50%, and 60% of MIF. RESULTS: A significant (p < 0.05) main effect of load existed for the leg press exercise, indicating that the 40% MIF load tended to elicit greater power output. For the bench press exercise, no significant effect of load existed. CONCLUSION: Loads of ~30% of MIF elicited maximal power output during dynamic leg presses and bench presses, respectively. These findings are similar to those obtained when testing is based on 1-RM.

Introduction

Maximal power capabilities strongly predict functional (3) and athletic performance (4). Therefore, substantial research has sought to determine the optimal load with which to test maximal power capabilities. Although some controversy exists (2), peak instantaneous power output is maximized when athletes perform ballistic movements using loads corresponding to ~30% of 1-RM (1). However, measuring 1-RM is not always feasible/appropriate. For instance, 1-RM testing prior to power measurement requires considerable time, especially when subjects are tested using multiple exercises; and 1-RM testing might be contraindicated in some populations (i.e., frail elderly, during injury rehabilitation, post-injury).

Maximal isometric force (MIF) is an alternative attractive strength measure for determining the optimal load for power testing due to lower time requirements and the inherent safety of the measurement (e.g., it does not involve eccentric muscle actions). Therefore, the purpose of this study was to determine the optimal load based on MIF for maximizing dynamic power output during ballistic leg presses and bench presses.

Methods

Experimental Design. Subjects performed isometric leg presses and bench presses, during which MIF was measured using force plates. Subjects subsequently performed ballistic, concentric-only leg presses and bench presses using loads corresponding to 20%, 30%, 40%, 50%, and 60% of MIF (presented in randomized order), during which maximal instantaneous power was measured using force plates and position transducers.

Subjects. Twenty healthy volunteers (mean ± SD; 12 men, 8 women, age: 31 ± 6 years, body mass: 72 ± 15 kg) consented to participate in this investigation. Test protocols and procedures were reviewed and approved by the Johnson Space Center’s Committee for the Protection of Human Subjects.

Procedures. Data were obtained using a leg press device (Nebula Fitness Equipment, Versailles, OH) and bench press power cage (Fitness Technology, Skyke, SA, Australia). Both devices were equipped with a force plate (Keller Instrument Corp., Amherst, NY) and position transducer (Fitness Technology).

Analyses. Data were analyzed using a repeated-measures ANOVA.

Results

Maximal Isometric Force: MIF values are presented in Table 1.

Table 1. Maximal isometric force values (mean ± SD).

<table>
<thead>
<tr>
<th>Leg Press (N)</th>
<th>Bench Press (N)</th>
</tr>
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<tbody>
<tr>
<td>Females</td>
<td>Males</td>
</tr>
<tr>
<td>(n = 8)</td>
<td>(n = 12)</td>
</tr>
<tr>
<td>398 53</td>
<td>188 50</td>
</tr>
<tr>
<td>618 212</td>
<td>331 142</td>
</tr>
</tbody>
</table>

Figure 1. Peak power output (mean ± SE) during ballistic leg presses using different loads based on a percentage of maximal isometric force (MIF). “+” denotes trend (P = 0.07) for difference in power output compared to 60% MIF load.

Figure 2. Peak power output (mean ± SE) during ballistic bench presses using different loads based on a percentage of maximal isometric force (MIF). Unlike symbols denote significant (P < 0.05) differences in power output between loads.

Conclusions

Maximal isometric force (MIF), which requires little time and is inherently safe to perform, can be used as an alternative strength measure for determining the optimal load for power testing.

The optimal relative load for measuring peak power output (i.e., ~30-40% MIF) is similar to that which is recommended when loading is based on 1-RM (i.e., ~30-40% 1-RM).

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References